ENGINEERING NEWS.

Tribune Building, New York City.

GEO. H. FROST, PROPRIETOR.

SATURDAY, SEPT 17, 1881.

WE have received from the Industrial Publication Company, 14 Dey street, New York, a copy of "No. 1 Work Manuals," a series of small handbooks, designed to give "thorough and reliable information in the plainest possible language upon the arts of every-day life," at twenty-five cents each volume. The number before us treats of "Cements and Glue." With the exception of the first few pages, which are devoted to the preparation and use of cement, the whole volume is taken up by the recipes for 177 different kinds of cement or glue. The series consists of eight volumes, of which this number only is ready for sale.

THE engineer in Holland is essentially the country's defender. All the great dikes have their corps of engineers, who devote their whole time and skill to keeping at bay the great enemy—the ocean. A very entertaining writer, Edmondo de Amicis, states that nothing gives a higher idea of man's power than the great system of defenses which is to be seen at every point. The drying up of the Haarlem Lake was in itself one of those gigantic jobs which was regarded at one time as impossible. But this work sinks into comparative insignificance alongside the projected draining of the arm of the sea known as the Zuyder Zee. The plans of the work have been laid before the Government, and operations will, it is said, soon be begun, The extent of ground is 200,000 hectares, or nearly 500,000 English acres. The works will be begun simultaneously at four points, and from eight to ten years will be required for their completion. The cost is estimated at $46,000,000 (230,000,000 francs). This stupendous sum alone places this enterprise as one of the greatest engineering projects. A dike of 41 kilometers in length will be built from the point of Enkhuisen to the coast of Over-Yssel. The crest of the dike will be five meters above the low-water mark at Amsterdam, or some two meters above the highest tides. The dike will be of sand and clay and protected at bottom by a system of osier works or fascines. The breadth will be everywhere sufficient to resist high seas. The cost per current yard will be about $250. The inside berme will be used as a tow-path, and finally a railway track will be laid on it. In addition to the dike large docks will be constructed, and some ten large canals, with numerous locks, so that there will be no interruption to navigation.

Each hectare thus drained will be worth $290. Thousands of soundings have been taken, which have shown that the bottom contains superior soil to that of Haarlem, which sells at $400 per hectare (2.4 acres). The first idea of draining the Zuyder Zee only dates from 1865. The engineering studies were only begun, however, in 1875. Owing to the enormous cost the State has undertaken a work which it was thought beyond the power of private enterprise.

PERSONAL.

Jas. H. Reno, County Engineer of Allegheny County, Pa., died Aug. 5.

Mr. George T. Hosmer, engineer of Pike's Hill Inclined Plane, has gone to Datona, Fla., where he will settle permanently.

Prof. George L. Vose of Bowdoin College has resigned, and will be professor of civil and topographical engineering in the Massachusetts Institute of Technology at Boston.

Chief Engineer Albert Astor, U. S. N., in charge of the stores at Portsmouth Navy Yard, died on Saturday, the 10th, of acute gastric fever. The remains were sent to his home, at Middletown, Conn.

The wedding of Mr. Fred. B. Sheldon, Chief Engineer of the Columbus & Toledo Railroad, and Miss Harriet E. Thrall, neice of Mr. Walter G. Thrall, took place at the residence of Mr. Thrall, Columbus, O., on the 8th inst.

N. C. Ray, C. E., has resigned his position of Assistant Engineer on the Chicago, Milwaukee & St. Paul Railway to accept a similar one on the Union Pacific Railway, with charge of construction through Boulder Cañon. His address is Sugar Loaf, Boulder Co., Col.

Prof. George H. Cook, State Geologist of New Jersey, has come to the conclusion that Cape May and Cumberland counties are slowly but surely settling into the sea. From facts in his possession he estimates that the surface has sunk about eight feet during the last one hundred years.

The government of Brazil has appointed Dr. Benjamin Franklin, de Albuquerque, Lima, to succeed Col. W. M. Roberts in the proposed surveys of the Rio das Valhas. The new engineer, accompanied by Professor Orville A. Derby, set out on the 23d of July on their journey into the interior of Minas.

Mr. Charles H. M. Blake, of Pawtucket, R. I., has been engaged to construct a portion of the Mexican Central Railroad, from the City of Mexico to the coast. He will sail from New York on the 22d inst. for Vera Cruz. Mr. Blake has a high reputation as an engineer, and is a brother of Mr. Blake, the inventor of the "transmitter" used on telephones.

The members of the senior class of Lehigh University return to their duties after having spent the summer in practical engineering work. Mr. Lawall has been engaged in the survey of coal mines at Hazleton; Messrs. Morrow, Emmerich and Ricksecker have been employed with Prof. Merriman on the U. S. Coast and Geodetic Survey's primary triangulation of Pennsylvania; Mr. Ruff has been at work in the machine shop of the Bethlehem Iron Company; Mr. Wittmer has been running levels in Allegheny County, and Mr. Sickler has been with one of the Lehigh Valley Railroad engineering corps. The students of Lehigh University are very fortunate in being able to familiarize themselves during their vacations with the practical work of the profession which they are studying.

THE VENTILATION OF TUNNELS.

Some interesting observations on the above important subject have recently been made in the Pfaffonsprung tunnel and a resumé of them given in the Swiss journal, *Eisenbohn*. In the case of long tunnels, the difficulties to be overcome are very great and, even with machines pumping air, the loss of strength, and even of life, is very great. The Pfaffensprung tunnel makes a spiral curve through a precipitous mountain, mostly composed of hard gneiss granite. Two streams traverse the mountain—the bed of one is through a layer of slate. The increase of temperature at a small distance from surface was 1° C. per 32 meters. The rapidity of the change of air is dependent on the difference between the average temperature in the tunnel, and the exterior air temperature. This difference is controlling for the difference in weight of the air column in the tunnel, and a communicating exterior air column of equal altitude. The greater this difference, the greater is the motive power. The temperature at the entrance is almost always even, as the incoming air rapidly acquires the temperature of the rocks with whose surface they come into contact. The colder exterior air which enters at the surface of the tunnel is gradually warmed, and finally takes its exit at the roof. Only a part of the incoming atmosphere arrives at the end of the opening, as many of the particles which are sufficiently heated pass into the upper and warmer current of retreating air, so that the quantity of air in a given cross section in a unit of time becomes less behind; that is, it decreases in rapidity. Towards the end of the cut the air is no longer fresh, as it has absorbed a great deal of moisture on the way, and passed along where the gases from blasting and lamp smoke have further deteriorated it. The rapidity of the air current is again increased on its return on the tunnel roof in proportion as the quantity is increased by particles coming from the underlayer. According, however, as this heated air approaches the entrance to the tunnel it gradually cools, and the aqueous vapors with which it is saturated are condensed so that a thick mist spreads around the tunnel.

The gallery roof, at 600 meters from the entrance, is naturally not approached by this air current. The bad air here stagnates, as it were.

Where the two drifts have been made the circulation is, however, very active. When the open air temperature is over 15° C., there is scarcely any perceptible circulation in the further parts of the tunnel, and the gases of the explosives and the smoke from the lamps act very oppressively. In the front part the circulation is the reverse of that at a low temperature. The warm air from outside enters at the roof, cools on the rocks and takes exit again by the floor of the tunnel.

It will be seen from the foregoing that a lower exterior temperature acts less favorably by its attracting cool air than it does by the fact of its favoring circulation. After cutting the perpendicular drift there was a decided change, and at 11° C. outside) there was immediately a lively air current towards the entrance. At 16° C. (exterior) here is hardly any circulation in the level drift, for there the air column in the tunnel has the same average temperature as that which communicates with the outside and maintains an equilibrium. It is certain that natural ventilation will be the worst at 16° C., and the more the temperature sinks below this point the more active will be the current from the lower to the upper outlet; the more it rises over it, the more active in the contrary direction. It is very fortunate that this medium temperature of 16° C. is not very frequent in the mountain district. In winter it is generally colder, in summer, warmer in the daytime, and at night cooler. The blasting gelatine was exclusively used, and the gases given out by each blast are as follows:

Steam	4,000 gr.
Oxygen	700
Carbonic acid	11,600
Nitrogen	3,700
	20,000 gr.

Only carbonic acid has any appreciable bad effect on the air; it concentrated on the floor, while fresh air entered above. The workmen on going toward the drift always had to hold their lamps as high as their head as they went out on the floor level. The blasting increased the temperature only from 18 to 22° C.

The temperature in a cutting is generally dependent (1) on the warmth of the surrounding mountain, (2) on the caloric production of the lights, (3) on the bodily warmth and breath of the workmen, (4) and on the quantity and temperature of the ventilating current. Of all these influences, that of the mountain temperature is the most important, so much so indeed that there can be little divergance between the temperature of the tunnel and that of the mountain. The presence of men and lamps heightens the tempera-

ture of the tunnel somewhat over that of the mountain, but with any considerable increase of this, the absorbing power of the mountain begins to act rapidly, so that its influence in combination with that of ventilation will effectually neutralize that coming from the men and lamps. Measuring these factors by calorics we find :

1. Mountain Warmth: As this is lower than the temperature in the cutting, the mountain takes up heat from it. In this case it was 8.9 calorics per minute.

2. Lamp Heat: The flame of a tunnel lamp consumes 15.5 gr. of oil per hour. Three lamps will give 8.5 calorics per minute.

3. Bodily Heat from Men: Eight persons give 3.5 calorics per minute.

4. The heat production from breathing is so inconsiderable that it may be left out of the question.

We thus see that the influence of human heat is to that of lamps in the proportion of 1:6, or that six men give out as much heat as a lamp. This influence rises or decreases with higher or lower temperature. At 32° it ceases altogether.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 365.)

LXXXVI.—NEW HAVEN.

New Haven, Connecticut, is in lat. 41° 18′ 23″ N., long. 72° 56′ 30″ W., on a sandy plain at the head of a shallow harbor, between West and Mill rivers and the Quinnipiack River, about three miles from Long Island Sound. Founded in 1638 as an independent colony, it was about 1680 brought under the jurisdiction of Connecticut by the charter granted that State by Charles II. It was incorporated as a city in 1784.

In 1860 the construction of water-works was begun by the New Haven Water Company, a private corporation, after the plans of Julius W. Adams, C. E., and water was first supplied on Jan. 1, 1862, Thomas N. Doughty, C. E., being the chief engineer after June, 1861, Col. Adams having resigned to enter the army.

Water is taken from Mill River, about 2 miles from the city, where the stream, with a water shed of 56 square miles, is dammed at a narrow gorge. The dam is 500 ft. long and 38.5 ft. high, built of heavy stone, from 3 to 6 ft. wide on top, and 25.7 ft. wide at the base, backed with 8 in. of concrete from the rock foundation to the water level. A gravel embankment is placed against this, 20 ft. wide at top and 100 ft. wide at its base in the deepest part of the river. The reservoir thus formed is called Lake Whitney, is 35 miles long and averages 20 ft. deep, holding 500 million gallons. An overfall 150 ft. long is constructed at the east end. From a chamber near the west wing, a wrought-iron 48-in. pipe, 13 ft. below water surface, conducts the water for supply and power to the pump house, where two 30-ft. back pitch overshot wheels, each with 80 buckets 6 ft. long, operate two pumps of 16-in. diameter and 60-in. stroke, forcing the water through 3,100 ft. of 16-in. cast-iron main to the reservoir on Sachem's Hill, 129 ft. above tide water, built in excavation and embankment. In plan the reservoir is an ellipse, with diameters of 488 and 244 ft. at water line, and 19 ft. deep. The bottom and slopes are covered with 18 in. of puddle overlaid with 4 in. of concrete, which on the slopes is overlaid with a 12-in. stone wall laid in cement. It is in two divisions. The force main is arranged to deliver into either the reservoir or the distribution pipe. A 16-in. cast-iron main 11,341 ft. long leads to the city. Two 12-in. mains have since been added.

In 1868 the waste way of the dam at Lake Whitney was raised 4 ft., increasing the storage capacity by 59 million gallons.

In 1871 a steam pump built by the Yale Iron-Works was erected for use when water was low, and a 24-in. wrought-iron and cement force main was added.

In 1876 the company purchased the property of the Fair Haven Water Company, consisting of reservoirs, pipes, etc., furnishing an auxiliary supply by gravity.

Distribution is principally by wrought-iron and cement pipe, which are manufactured by the company after a method designed by D. Goffe Phipps, the secretary of the company.

There are in use 80 miles of this pipe and 22 miles of cast-iron pipe, with 362 fire hydrants, 4,904 taps and 54 meters.

The population in 1880 was 62,882. The consumption is not given.

The cost of the original works was $357,045.62.

The extensions and maintenance have cost $485,475.93, and there has been paid for interest and dividends $958,421.15. The total receipts from water rents have been $1,625,626.91. The capital stock is $900,000, and the bonded indebtedness $325,000.

Daniel Goffe Phipps has been the secretary since 1865.

The question of the purchase of the works by the city is now under discussion.

LXXXVII.—HAMILTON.

Hamilton, Canada, is on Burlington Bay, at the western extremity of Lake Ontario, in lat. 43° 16′ N., long. 79° 50′ W. The city is on sloping ground, extending from the bay for about 1¼ miles to the foot of a hill. It was settled in 1779, but as late as 1830 had only 653 inhabitants. In 1859–61 water-works were built by the city, after the plans of Thomas C. Keefer, C. E., taking the supply from a filter basin on Burlington Beach, a sand and gravel bar which separates the bay from Lake Ontario. The water of the bay is unfit for use, in consequence of its being the receptacle of the city sewage and the wash of the streets and the surrounding territory, which is a red clay; also of the drainage of enormous vegetable deposits in the great Desjardin Marsh. The lake water is reddened by the wash of the clay banks, and at times is filled for miles with fine sand held in suspension.

A basin of 1½ acre area was dredged in the beach to about 6 ft. below the level of the lake. This basin has furnished pure water. It was enlarged and deepened about 1872. In October, 1879, continuous pumping at the rate of 2.5 million gallons per day for a week lowered its surface 2.6 ft. below the lake level.

Two compound condensing beam and fly-wheel engines, with bucket and plunger pumps, with vacuum vessel on the suction and large cast-iron air chamber on the force mains, lift the water into a reservoir.

The high-pressure cylinders are 24-in. diameter and 72-in. stroke. The low-pressure cylinders are 42-in. diameter and 96-in. stroke.

The Barton reservoir, of 15,000,000 gallons capacity, is nearly midway between the pumps and the city, on the mountain side, 185 ft. above the lake. The pumping main, of 18-in. diameter and 6 miles long, leads directly to the distribution, with a side branch leading to the reservoir which is thus made a side pocket to receive surplus or supply deficiencies. The commercial part of the town is 70 ft. above the lake. A small engine pumping into a tank supplies a few houses on the hill above the reservoir level.

The loss of head in the city from increase of consumption and inadequate mains became so great that in 1870 a plan proposed by J. C. Keefer and John Kennedy was adopted, by which the pumps are to be enlarged, another 20-in. force main laid, and a central reservoir built in the city.

The distribution is by cast-iron pipe, of which 65 miles are in use, with 438 fire hydrants and 8,200 taps. Two meters are in use.

The population in 1880 was 35,009, and the daily consumption about 1,800,000 United States gallons.

The works cost $650,000 up to 1860.

The total expenditures to Dec. 31, 1880, were $945,353.38, and the receipts $397,793.17. In 1880 the receipts were $99,729.07, and the expenses for maintenance $27,628.56, and for new construction, $75,193.24. The bonded debt is $991,878.36. The works are controlled by a Committee of the Council. William Haskins, C. E., is the manager.

LXXXVIII.—WILMINGTON.

Wilmington, Delaware, is in lat. 39° 43′ N., long. 75° 32′ W., at the confluence of the Brandywine and Christiana creeks at the head of navigation, about 2 miles from the Delaware River and 28 miles from Philadelphia. The city is built on elevated ground between the two creeks. The vicinity is hilly and the bed of the Brandywine rises 120 ft. in 4 miles.

The city rises from the creek level on three sides, reaching an elevation of 243 ft. at its northwest boundary.

The first Swedish colony in America landed here in 1638. In 1698 a Swedish church was built which is still standing. The town was founded in 1732, incorporated as a borough in 1740 and as a city in 1832.

In 1803–4 "The Wilmington Spring-Water Company" was organized for the purpose of supplying the borough with spring water. A "fountain" was opened in High, now Fourth street, and supplied that part of the town below Fourth street. In 1810 the borough purchased these works for $10,000. The water was conveyed from the springs in wooden pipes, along the principal streets, to cisterns, from which it was drawn by pumps. The supply gradually failed, from 35 gallons per minute in 1810, to 14 per minute in 1820.

In 1825 a 3-in. iron pipe had been laid to a reservoir between Chestnut and Elizabeth streets, now Tenth and Eleventh streets, and Market and Orange streets. A contract was made for iron pipe and fire-plugs to conduct the water from this reservoir down Market street to High (Fourth) street.

In 1827 a water power was purchased on the Brandywine, which was used to drive an overshot wheel 14.5 ft. in diameter, and 45.25 ft. wide, which worked a double acting force pump of 8-in. bore and 72-in. stroke, which lifted the water 99 ft. through 2,120 ft. of 8-in. pipe into two reservoirs. In 1832 another similar pump was added. On July 1, 1879, the wheel went to pieces. A Jonval turbine, working two pumps of 1.6 million gallons capacity in 24 hours was ordered, and was, after much delay, put in operation on Jan. 5, 1881.

In 1855 a Cornish bull engine was erected, with pump of 18-in. diameter and 90-in. stroke, and a capacity of 3,000,000 gallons in 24 hours. It was always held in reserve, and run only when the water power or other steam pumps failed. It has not been used since 1877.

In 1864 a Worthington duplex high-pressure pump with pump cylinders 10 in. in diameter and 9-in. stroke, with capacity of 550,000 gallons in 24 hours, was erected, taking water from the pipes at Tenth and Market streets, and raising it to a reservoir at Eighth and Rodney streets through an 8-in. main.

This pumping station was abandoned in 1878, and the engine repaired and removed to the Cool Spring pumping station, where a Knowles pump of 1.5 million gallons capacity was also placed in 1880.

In 1872 a Worthington compound duplex engine

* Copyright 1881.

of 5,000,000 gallons capacity was erected, and is still the main dependence of the works.

In 1827 a reservoir was built at Market and Tenth streets, 99 ft. above the creek, with two basins of a combined capacity of one million gallons, afterward enlarged to contain 2.5 million gallons.

These reservoirs were abandoned on June 19, 1879, and removed.

In 1864 a high-service reservoir of 1.5 million gallons capacity was built at Eighth and Rodney streets, 210 ft. above the creek. It is in excavation and embankment, the inside slopes lined with clay puddle and paved with brick laid in cement.

The construction of another reservoir, called the Cool Spring reservoir, was begun, by days' work, in 1874. An estimate of the cost, made in October, 1874, for a basin 18 ft. deep and holding 28 million gallons, amounted to $86,000. Up to November, 1876, there had been expended $129,282.50, and it was estimated that $90,000 was required to finish it. The work was then not satisfactory to the chief engineer. A drain intended to carry off water from springs had become stopped and the water passed through the bank into the reservoir. The bottom had been underlaid with iron pipe of 2, 3 and 4-in. diameter, intended to drain underlying springs. Some of these pipes were laid with lead joints and some with open joints. The inlet and outlet pipes were laid through the banks without proper precautions against water passing along them. In 1877 a special water commission was created by the Legislature to complete the reservoir. The adjoining land was filled up to divert surface water from the banks. The bottom and slopes were puddled with 2 ft. of clay, and the slopes lined with two courses of brick, on edge, in cement. The bottom puddle was covered with gravel rolled in, and then paved with bricks laid flat in sand. Collars of masonry were placed around the pipes. One basin, holding 11 million gallons, was finished in this manner, and the water introduced in December, 1877. The other basin was finished in October, 1878. Water is pumped from the Brandywine into the north basin, passes over the division wall into the south basin, and thence to the distribution pipes. In November, just after the reservoir had been filled, an increase in the flow of the under drains was noted, and a small hole was discovered in the bottom of the north basin. It was stopped up and no further trouble occurred until March, 1880, when the slope pavement on the east side of the south basin slid down partially, for about 100 ft. in length. It was repaired by building at the foot of the slope a wall 33 in. wide at the top and 39 in. at the base, made with brick taken out in blocks from the damaged brick lining. The puddle under the damaged brickwork was taken out and repuddled, and the paving relaid. The north and west walls of the north basin were strengthened at the base in a similar manner. The total repairs cost $2,365.

In 1878 the flow from the spring west of, and the drainage under the reservoir, was 43,185 gallons per day.

The Cool Spring reservoir is 140 ft. above the creek and the Rodney street reservoir 106 ft. higher, now supplied from a pumping station on Tenth street, near the Cool Spring reservoir.

Distribution is by cast-iron pipe, of which 51.65 miles were laid in December, 1880, with 470 hydrants and 4,344 taps.

The population in 1880 was 42,499, and the daily consumption 3,564,856 gallons. The cost of the works has been about $450,000.

The consumption, expenses and revenue for five years past have been as follows:

	Consumption million gallons.	Expenses.	Revenue.
1876	1.82	$76,302.75	$53,240.34
1877	2.64	40,899.86	55,052.08
1878	3.11	32,694.38	57,173.07
1879	3.58	29,137.00	60,029.13
1880	3.56	42,719.99	68,404.23

The maintenance alone costs about $18,000 per year.

The works are managed by the water committee of the City Council. C. H. Gallagher was the chief engineer for some years before 1877. Henry B. McIntire has held that position since 1878.

LXXXIX.—LYNCHBURG.

Lynchburg, Virginia, is in lat. 37° 22' N., long. 79° 4' W., on the south bank of the James River, 90 miles from Richmond. The city is built on a steep acclivity, rising from the river bank and breaking into numerous hills. The town was laid out 1786.

In 1799 "The Lynchburg Fire Company" obtained leave from the trustees of the village, "to sink wells and erect pumps on Main street for the convenience and safety of the citizens." This privilege was exercised to a very limited extent. In 1811 the council granted to John Lynch the privilege of conveying water in wooden pipes through the streets from the springs at the head of Horse ford Branch, reserving to the town the right to use the water for extinguishing fires free of cost. In 1813 the town authorities built a reservoir 12 ft. square near the market-house, and established four fire-plugs. The water was conveyed about 4,000 ft. under 40 ft. head, from the springs to the reservoir, and distributed about 2,500 ft. on Main street. The pipes were 10-in. logs, with 3-in. bore and 10 ft. long, jointed like pump logs and banded at the joints with iron. A log house was built over the reservoir. This was removed in 1880. John Lynch sold his rights to James Wade in 1817. The wooden pipes were all taken up in 1828, except two sections, which were discovered in 1869 in making a sewer excavation, and were in a good state of preservation. They were secured by Mr. Forsberg, the city engineer, but were stolen from him by negroes for fuel.

In 1828, the population being about 5,000, waterworks were built by the town, after the plans of Albert Stein, C. E., taking the supply from the James River. A dam at the lower end of Daniel's Island and a series of dams above, connecting Jones & Woodroof's Island with the opposite shore were built, and water conducted by a race to the pump house, where a breast wheel 19-ft. in diameter and 9.5-ft. wide operated a pump of 10-in. diameter and 48-in stroke, which forced the water 22,000 ft. through a 7-in. cast-iron pipe into a reservoir built in excavation, its bottom paved with brick laid in cement, and its slopes paved with cobble stones, and containing 500,000 gallons, with a depth of 10 ft. at 255 ft. above the river. The bottom of this reservoir leaked for many years. The pipe for draining it was placed 1 ft. above the bottom, which increased the labor of cleaning out the sediment from the river water, which is deposited at the rate of 4 in. per year.

This reservoir is now reported as in a dangerous condition.

In 1835 the James River & Kanawha Canal Co. contracted to keep the dams, canals and races belonging to the city perpetually in repair, and to supply water to an amount not exceeding 600,000 gallons per day for consumption and enough water to furnish power to lift that quantity into the reservoir. A freshet in 1870 so injured the canal that the supply of water to the city was cut off, and the company was unable to repair its works except by procuring a loan from the city of $35,000 and assigning to the city all leases for water drawn from the canal. In 1877 another flood caused damage which was repaired by a second loan of $15,000, secured by second-mortgage bonds on the canal property. These bonds have been compromised by the payment of $3,305.83 by the Richmond & Allegheny Railroad Company, the successors of the canal company. On Aug. 5, 1881, by a contract with the railroad company, the city is guaranteed one-fifth of the entire flow of the James River, the minimum flow of which is estimated at 1,000 cubic feet per second.

In 1868 a 60-in. Reynolds turbine was put in, operating a pump of 12-in. cylinder and 60-in. stroke, designed by A. Forsberg, C. E.

In 1879 R. D. Wood & Co. began the construction of two vertical plunger and bucket pumps, operated by a Jonval turbine, and so arranged that during freshets in the river the power can be supplied from a horizontal steam engine of 20-in. diameter by 30-in. stroke, with two tubular boilers of 50 horse-power each. The capacity of these pumps is one and a half million gallons in 24 hours, with 330-ft. lift to the high-service reservoir, located 4,400 ft. from the works.

In June, 1881, the old pump and breast-wheel, constructed in 1828, were removed to give room for a forebay to the new works, and a Knowles steam pump of 18-in. steam and 12-in. water cylinder, 18-in. stroke, was erected, pumping 500 gallons per minute to the low-service through the old 7-in. main.

The piston pump, constructed in 1868, is now being renovated and supplied with a new turbine. The council has also authorized the erection of a duplex, double plunger pump of 2,000,000 gallons capacity. The plunger pattern has been adopted on account of the gritty water and trouble encountered by the piston packing. When this pump is completed there will be a total pumping capacity of 5,000,000 gallons. Steam-power, however, will only be used in case of high water in the river.

In 1869 Samuel Miller bequeathed to the city $20,000 on condition of its use in 10 years toward payment of the cost of "furnishing a supply of water to persons residing on the hill west of the city not now supplied with the James River water," and in 1877 and 1878 a high-service reservoir was built on College Hill, 75 ft. higher than the old reservoir. It is circular in plan, with 232 ft. diameter at the top, and inside slopes of 2 to 1 lined with two courses of stone flagging laid in cement. It is 16 ft. deep, holds 4,000,000 gallons, and cost, including land, $23,480.55. The excavation for the reservoir was through a bed 10 ft. thick of dark tenacious clay, in which sandstone boulders were thickly imbedded. This bed was overlaid with a foot of red clay and underlaid with porous gravel. The same pumps supply both reservoirs at present.

The low-service reservoir is now to be enlarged to the same size as the high-service, which will give a total storage capacity of eight million gallons.

A new 18-in. pumping main will also be laid as soon as practicable.

The distribution is by cast-iron pipes of from 3 to 18 in. diameter, of which nearly 13 miles are in use, about one-third being of less than 6 in. diameter. There are 136 gates, 131 fire-hydrants and 750 taps. Meters are not used. The first pipes laid were unprotected from corrosion, and the river water, which is very soft, caused the formation of tubercles to such an extent as to interfere seriously with the distribution. A 3-in. pipe in Main street was found in 1858 to have its diameter reduced nearly one-half, and a new one was laid, the old one being still retained, but so weakened by corrosion that a tap could not be made without strengthening the pipe by wrought-iron bands or cast-iron sleeves. A section of a 4-in. pipe, which had been in use for 48 years and was badly corroded, was contributed by Mr. Forsberg for exhibition by the American Society of Civil Engineers at the Centennial Exhibition in 1876.

These original pipes were manufactured in Philadelphia. They were of exceedingly hard metal, were in 9-ft. lengths, with 4-in hubs. The 3-in. pipe were $\frac{3}{16}$ in. thick and the 4-in. were $\frac{5}{16}$ in. thick. They were evidently cast horizontally, and many of them were so irregularly cast as to be

scant ⅜ in. thick on one side, and full ¾ in. on the other. They are supposed to have been made by Wood & Co., whose foundry at that time was supplied with metal from their furnace making charcoal iron, chiefly out of Delaware and New Jersey bog ores.

Since 1868 all pipes have been coated with Dr. Angus Smith's preparation, with the result of entirely preventing corrosion.

The population in 1880 was 15,959 and the daily consumption 1¼ million gallons. The original cost of the works in 1828 was $50,000. The total cost for construction has been $171,102.88, and for maintenance, repairs and salaries, $51,378.18. The expenditures for 1880 were $6,841.37 and the receipts $12,337.05.

The works are managed by a committee of the Common Council. The city engineer, August Forsberg, C. E., has had since 1866 the charge of construction and general control of the works. James Allen has been the superintendent since 1874.

CORRECTIONS.—Sept. 10, p. 364. *Syracuse*—1st, 3d and 5th paragraphs, for *Oliver Tease*, read *Oliver Teall*. 1st paragraph, for *Aaron Borst*, read *Aaron Burt*. 3d paragraph, for *Stolf's Spring*, read *Stolp's Spring*.

Sept. 10, p. 364. *Danbury*—Second line, for *Paliquioque*, read *Pahquioque*. *5th paragraph*, insert: The dam is 330 ft. long, 30 ft. high and 22 ft. wide at bottom, built of dry stone, except a lining wall, which is made water tight by being laid in cement mortar. *Ninth line from bottom:* There are 2,000 taps. *Sixth line from bottom:* The daily consumption is not known. The supply is all that the consumers need. Some meters were set soon after the introduction of water, but caused so much trouble by freezing up that their use was discontinued. Service pipe are generally of galvanized iron. *Last two lines*, insert: The annual cost of maintenance is about $1,000. The bonded indebtedness is $148,000. This includes the cost of the proposed extensions. The water commissioners pay interest on bonds out of the receipts, and if there is any surplus the borough directs how it shall be used. The engineer of the works is David G. Penfield, C. E.

ACKNOWLEDGMENTS.—Received from A. C. Sekell, City Surveyor and Supt. W. W., Report of Board of Public Works of Grand Rapids, Mich., for April 30, 1881. From A. Forsberg, City Engineer, Lynchburg, Va., Reports of city officers of Lynchburg for 1878 and 1880, and notes on water-works. From T. C. Keefer, C. E., Reports on Proposed Extension of Hamilton, Canada, Water-works, by T. C. Keefer and John Kennedy, 1879, and Historical Sketch of Hamilton Water-works. From Edgar H. Brown, Treas., Sec. and Supt. W. W. Co., Historical Sketch of Water-Works of Syracuse, N. Y. From E. H. Keating, City Engineer, description of water-works of Halifax, N. S. From F. B. Rhoads, Supt. Water Dept., Annual Report of Phœnixville, Pa., Water Dept., and sketch of works. From John W. Bacon, C. E., sketch of water-works of Danbury, Conn. From H. B. McIntire, Chief Engineer Water Department, Annual Reports of the Water Department of Wilmington, Del., 1876, '7, '8, '9, 1880.

CORRESPONDENCE.

BEST BOOKS ON SEWERAGE.

QUEBEC, Sept. 10, 1881.

EDITOR ENGINEERING NEWS:

Can you inform me what is the best work on sewerage for towns and villages, one which embodies the vat system, as well as other methods of disposing of sewerage material.

Respectfully, E. MOORE.

[By "vat system" we suppose our correspondent means the treatment of sewage by precipitation. The best work which embodies the sewerage for towns and villages, as well as the methods of disposal, is Bailey Denton's "Sanitary Engineering." The most complete and scientific treatise on sewerage alone is Latham's "Sanitary Engineering." The best books on sewage precipitation are: Robinson and Mellin's "Purification of Water-carried Sewage." London. 1877. Robinson, "Sewage Disposal." London. 1880. Another good little book on sewage utilization alone is Burke's "Sewage Utilization." London. 1873.]

GORDON'S FORMULA AND PHŒNIX COLUMNS.

PHŒNIXVILLE, Pa., Sept. 12, 1881.

EDITOR ENGINEERING NEWS:

DEAR SIR: Various technical periodicals of recent date extract from a paper presented to the American Society of Civil Engineers, a "record of tests" made on Phœnix colums at the Watertown testing machine. This extract is supplemented in each case by the remark that the results thus obtained *show the inapplicability of Gordon's formula to these columns.*

No well-informed engineer interested in this question can let such a statement pass uncriticised. In reality the discordant results are due not to Gordon's formula, but to the persistence of engineers to use that formula in a manner altogether unwarrantable.

It is well known that Gordon deduced the various constants from Hodgkinson's experiments, and that they therefore represent *English iron.* But the constants: 36,000 ($=f$) and $\frac{1}{36000}$ ($=a$) are to be used *for solid rectangular sections only*, and this is plainly stated by the various authorites (Rankine App. Mech., p. 362) (Rankine Civ. Eng., pp. 237 and 522), hence the utter absurdity of applying these constants to columns of *American manufacture and of any cross-section*, and then announcing that the results by Gordon's formula do not agree with experimental inquiry.

That engineers generally fail to recognize this fact, is shown plainly enough by various published records of similar experiments, for while they note many details; just such data as would enable one to make necessary calculations are omitted—I refer to data allowing the calculation of the radius of gyration.

In order to substantiate the above, and to show that a right application of Gordon's formula will give results agreeing quite closely with experiment. I have calculted "f" (ultimate strength in pounds per square inch) by that formula and compared the same with the record referred to above. The following tabulated statement admits an easy comparison:

I.—No. of experiments.	II.—Length of columns.	III.—Area of cross section.	IV.—$\frac{l}{d}$	V.—r^2.	VI.—"f" in lbs. per sq. in. (by experiment).	VII.—"f" in lbs. per sq. in. (by formula).	VIII.—Differences of cols. VI. and VII.
	Feet.	Inch.					
1	28	12.062	42	9	35,150	33,576	1,574
2	28	12.181	42	9	34,150	33,576	574
3	25	12.233	37.5	9	35,270	35,000	270
4	25	12.100	37.5	9	35,040	35,000	40
5	22	12.371	33	9	35,570	36,367	797
6	22	12.311	33	9	34,360	36,367	2,007
7	19	12.023	28.5	9	35,365	37,650	2,285
8	19	12.087	28.5	9	36,900	37,650	750
9	16	12.000	24	9	36,580	38,820	2,240
10	16	12.000	24	9	36,580	38,820	2,240
11	13	12.185	19.5	9	36,857	39,845	2,988
12	13	12.069	19.5	9	37,200	39,845	2,645
21	25 ft. 2.65 in.	18.30	25.6	20	36,010	38,475	2,465
22	8 ft. 9.50 in.	18.30	9	20	42,180	41,537	643

Columns 1, 2, 3 and 6 are obtained from published accounts, 4 and 5 by approximate calculations, 7 by calculation by formula, and 8 by subtracting results of columns 6 and 7. The radius of gyration was assumed to be the same for all 4 segment columns. No graphical representation will be needed, the last column showing plainly enough the character of the results. The form of Gordon's formula employed in the above calculations is:

$$p = \frac{42{,}000}{1 + \frac{1}{50{,}000} \times \frac{l^2}{r^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1.)$$

and is extracted from a lecture delivered by Prof. Burr before the class in Civil Engineering at the Rens. Poly. Inst., since published in Vol. 2, No. 2, of the papers of the Pi Eta Scientific Society, and reprinted in ENGINEERING NEWS of July 30, 1881. The constants here used are deduced from American experiments, and hence *American iron*, while the term $\frac{l^2}{r^2}$ allows the adaptation to *any form of cross-section.* It will be noticed that some of the experiments have been omitted. They are those in which the ratio of length to diameter becomes small, for then we have no more a "long column," and our formula being deduced for such only does not apply.

It is also seen that for a column 25 ft. long the results of formula and experiment are almost identical. I find that this is exactly the mean length of the Phœnix columns experimented upon by Bouscaren, and from which the formula used was deduced. Hence it would seem that, were the above constant determined from a greater number of reliable experiments, results by the same would be still more accurate, while the addition of a term in the numerator might allow its application to columns of more varied lengths.

GEO. A. JUST.

P. S.—While discussing the above it has been remarked, that with such a change of constants the formula is no longer that of Gordon.

Now this is an entirely erroneous notion. Gordon's formula virtually consists of two distinct parts; the one entirely mathematical, and therefore perfectly general (the proof of which is known to every engineering student), the other empirical, and hence adapted to material of one manufacture only. Names (instances can be drawn from almost every branch of engineering) are affixed to the analytical formulæ, hence it is wrong to hinge the name in this case on the constants. Gordon's formula always will remain Gordon's formula, no matter what changes may take place in the constants.

Again, it has been urged that American manufacturers are frequently called upon to proportion columns according to Gordon's formula, and that tests as the foregoing were intended to illustrate both the unfairness of the requirement and the superiority of American iron. This may seem to offer an excuse for employing old constants, but it does not touch upon the matter of cross-section; and surely no engineer would dare endanger his reputation by forcing the application of a formula to circular columns (or what is still worse, to "built columns"), which was deduced for solid rectangular cross-sections only.

Gordon's formula, used as it should be, is as good to-day as when originated, and will, when applied with a knowledge of its derivation, give results accurate enough for the purposes of the engineer.

G. A. J.

WIND PRESSURE.

PITTSBURGH, Sept. 12, 1881.

EDITOR ENGINEERING NEWS:

In your number of Aug. 20, I notice an article of Mr. E. J. Ward, C. E., which refers prominently to a remark I made at the conclusion of my discussion of a paper read before the American Society of Civil Engineers by Mr. C. Shaler Smith, on Wind-Strains.

Judging from Mr. Ward's remarks, it seems I was not as clear as I intended to be, and would,

therefore, request you to give a little space in your valued paper to the following:

In the first place I did not say that the practice of the C. and A. R. R. to increase every member in the bridge to meet the increased strains produced by wind to be wrong in principle, although I did not know then the exact mode Mr. Ward applied to determine the amount of such increase, but simply stated: "I believe this unnecessary," etc. I still hold the same view for the following reasons:

In every properly constructed railroad bridge of modern style there is an addition of at least 25 per cent. made to the material in floor beams and track stringers, over and above the section required to meet maximum strains. To floorbeam suspenders an addition of from 50 to 100 per cent., to middle main ties 10 to 25 per cent., is made to provide for the impact produced by the sudden application of loads of a rapidly moving train as well as to meet the shocks caused by imperfections in the track and rolling stock. This addition of percentages is not, and cannot be, the result of calculation, but is an arbitrary assumption, believed to be sufficient to meet extreme emergencies.

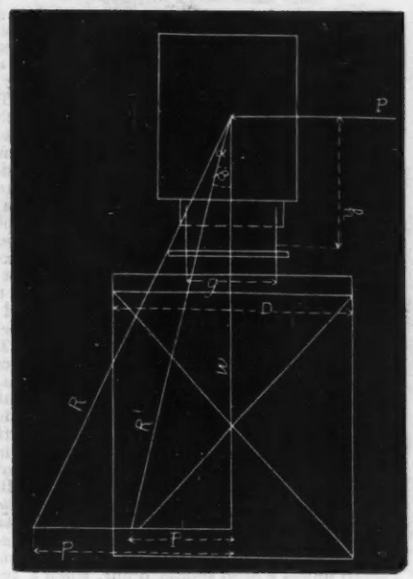
Now why should this increase in section not be also available to resist extra strains from wind pressure? With all due deference to the contempt Mr. Ward seems to have for the "factor of safety" in one place, and then again not in another, this can be readily conceded, considering the fact that not all of the floor beams or strainers of a bridge are subject to the maximum possible live load, for which they have been proportioned, at the same time.

The truss members, even if no addition to their section is made for impact, are generally proportioned for a live load, consisting of two locomotives coupled together, followed by loaded cars, or the equivalent of such load, besides the dead load of the structure. As, however, the wind will have the largest effect upon a bridge when the same is loaded with cars only, and empty cars at that, it is evident that at the same time the members will not be fully strained from the live load for which they had been proportioned. For these reasons, I believe, no additions in sections for wind strains in truss members are needed.

Mr. Ward states that they allow the same unit strains for members intended to resist wind strains only, as in any principal member of the bridge. (Is this not a preference of a higher degree of the ill-reputed "factor of safety?")

This mode certainly facilitates the work of the calculating engineer, but is neither necessary from an engineering point of view nor economical. If Woehler's law is worth anything it shows that those parts of a structure which receive the largest *number* of applications of weights, or strains, must be constructed with a larger factor of safety or smaller unit for working strain than those members less frequently strained, even if the loads or strains be the same in either case. Consequently, strains from wind pressures, which occur seldom only, compared with the other modes of loading, admit of a larger working strain, and even 15,000 pounds per square inch is yet too large, compared with 10,000 pounds for principal members.

If Mr. Ward has carefully read my remarks on Mr. Smith's paper, he would have found that right at the outset I called attention to the importance of having all "connections" of different members equally as strong as those members. Naturally, I class pins as well as other devices with "connections," and did not deem it necessary to spread myself on this subject. I fail to see what induces Mr. Ward to mention the failure of pins in State street draw or Prairie Creek bridge, as he states himself that Prairie Creek bridge was originally constructed for a much lighter rolling load than afterward subjected to; consequently it would be more natural to conclude that the pins were bent by actual load strains than by wind force. The same holds good for State street bridge. The following calculation of the excess of load brought to bear on the leeward truss by wind pressure seems to me more accurate than the one stated by Mr. Ward, inasmuch as the plane for x, or the plane in which overturning may take place, is taken at the level of the top of rails, instead of top of floor beam, as Mr. Ward does, which gives results about 25 per cent. smaller, y being so much smaller.



Let P be the wind pressure per lineal foot.

y Distance of center of gravity of side of car exposed to wind from top of rail.

g Gauge of track.

D Distance apart center to center of trusses, or distance between supports of floor-beams.

w Rolling load per lineal foot.

Then for equilibrium

$$Py = \frac{w\,g}{2} \text{ and } P = \frac{w\,g}{2y}.$$

$$\text{If} \quad P = \text{or} > \frac{w\,g}{2y}$$

then the entire load will be carried by the leeward track stringer (provided the same is directly under the rail). The proportional load carried by the leeward truss, as long as the structure is not overturned, will be

$$w\,\frac{D+g}{2\,D}$$

and the excess of live load on the leeward over the windward truss will be

$$w\,\frac{D+g}{2\,D} - \frac{w}{2}$$

$$\text{If} \quad P < \frac{w\,g}{2\,y}$$

then the proportional load on the leeward truss will be

$$w\,\frac{D+g\,\frac{tgt.\,\beta}{tgt.\,\alpha}}{2\,D}$$

where α is the angle, which the resultant R, of the wind pressure P, which would just balance the live load, or be equal to

$$\frac{w\,g}{2\,y},$$

and of the load w, forms with the perpendicular; and β is the angle which the resultant R' of any other wind pressure $P_1 < P$ with the same load w forms with the perpendicular.

As to the excess load on the leeward truss, arising from the weight of the structure itself, it is hardly worth while to make a calculation. If any such calculation, however, is made, then not the total weight of the structure, as Mr. Ward assumes, is to be taken into consideration, but only the weight of the floor and lateral system, as no part of the weight of the windward truss can be transmitted to the leeward truss, even if the structure should be overturning, except in the case of a deck bridge, with vertical diagonal bracing at each panel point, provided said bracing is strong enough to perform that office. A. GOTTLIEB.

ERRATA.

In the article on "*Running Parallels of Latitude*," in the number for July 30, 1881, page 306, middle of 3d column, for 26'—*k tan. Lat.*, read 26" *tan. Lat.* There are also one or two slight discrepancies in referring to the number of the figures, but such as will cause no serious inconvenience, and no error.

RESERVOIRS AGAINST INUNDATIONS.

The last number of the *Annales des Ponts et Chaussées* contains the views of M. Gros, Inspector General *des Ponts et Chaussées*, on the inadequacy of reservoirs to counteract the dangers of inundations. The French rivers are liable to rapid and disastrous rises, so that the results of the remedies proposed are of great interest. After the disastrous floods of 1856 it was resolved to try reservoirs for the purpose of at least retarding the rise of the waters. The inundation of the Garonne in 1875 showed the futility of such attempts. Lately a petition was presented to the French Legislature to have immense reservoirs in the Pyrenees and Cevennes mountains.

M. Gros, in order to combat what he terms false ideas, states that the basins of the Garonne, Rhone, Loire and Seine, and other important rivers, have been studied. The inundation of 1875 showed that on the hypothesis of an inundation of the same extent, the total capacity of a reservoir to protect Toulouse *alone* would have to be 550,000,000 of cubic meters, and three times this if Agen and the rest of the basin were to be defended. The capacity of the reservoir of Saint Ferreol being only 6,000,000 cubic meters, no fewer than one hundred such reservoirs would be requisite to defend the Valley of the Garonne. But it would not be possible to have more than 92 reservoirs, giving a total capacity of 290,000,000 cubic meters, and only 12 of these, with a capacity of 87,000,000 cubic meters, would be of any real value in case of high floods. Thus only one-sixth of the requisite protection could be afforded in any case. Similar experiments with the affluents—as the Tarn and the Lot—have given like results.

But aside from all this, such checks could have no effect unless on rivers of certain importance and with high dams. In the mountainous regions, moreover, the capacity is lessened by the declivity of the ground and by the danger of their being filled up by matters brought down by the torrents. But it was seen during the inundation of the Garonne in 1875 that the extraordinary rains which produced it fell outside the mountain zone. According as the river lengthens, the effect of the reservoir is less, owing to increased volume, etc. A drawback of 100,000,000 of cubic meters on the Garonne at Toulouse, would be only as one of 50,000,000 at the mouth of the Tarn, and one of 40 millions at Agen and 18 millions at Tonnein, but as the freshets of an affluent are generally in advance, the reservoirs which would be built on them would only retard the arrival of the maximum, and make it only coincide with that of the principal stream. The intensity of the rise would therefore be only increased instead of lessened, and the reservoirs would be a real injury. Besides this, freshets not happening always in the same order on the same streams, we should have another source of danger. The whole question would be difficult of solution. Then there are successive rises, separated at short intervals. In the Garonne, in 1856, five floods formed a single one, which lasted two months. What would become of the reservoirs in such a case?

Articles of association of the Chicago, Brazil & Ohio River Railroad and Coal Company have been filed. The capital stock is placed at $7,000,000, and the directors are Chauncey Vibbard, Arthur Holmes, A. D. Mallick, Fred. C. Schuster, Joseph P. Reford, George B. Gurly and George W. White. The proposed road will run from Jasper, Dubois County, through the counties of Martin, Owen, Clay, Parke, Montgomery, Tippecanoe, White and Jasper, to Hebron, Porter County, a distance of 350 miles.

THE INTERNAL CORROSION OF CAST-IRON PIPES.*

The following remarks deal with the internal corrosion of cast-iron water-carrying pipes, as observed in the city of Aberdeen, with estimates of the cost of getting rid of the obstruction, and as to the loss of space and pressure due to the same.

I.—GENERAL DESCRIPTION.

The rust is invariably of a brown color, presents an uneven surface, and in many cases appears to be formed in distinct layers. If taken from a pipe after long continued use it is exceedingly hard, and does not, unless disturbed, affect the color or purity of the water. When dried it becomes crisp, and is easily ground to a fine powder of a yellowish-red tint.

The pipes are usually in one of two conditions. The first is that in which the iron is directly exposed to the action of the water; the second, that in which the iron is protected by a coating of asphalt. In the former, the corrosion commences and continues uniformly distributed, growing with considerable rapidity; while in the later it appears in detached carbuncles or knots, at points where the protective coating is weakest; these, gradually increasing and enlarging, coalesce, and the rust then grows as rapidly as if no preparation had been made to resist it. This chemical change may commence at once in a pipe not specially prepared to resist it, but seven to nine years usually elapse before it has any appreciable effect on one coated with asphalt.

The carbuncles from a pipe coated with asphalt usually have a cavity in the under surface, being attached by their edges only. This form may be caused by the blistering of the asphalt coating through the collection of air or other gases, thereby preventing the central portion of the carbuncle from touching the iron (Fig. 1).

As an illustration of the fact that the corrosion is proportional to the volume of water passing along a pipe and the commotion existing therein, it is found that while main pipes, through which water is constantly passing, are nearly filled with rust, their fire-cock branches, through which it but seldom flows (though they are constantly full) are comparatively clean. The following example shows the difference in the amount of corrosion in the same pipe. The pipe *A B C*, Fig. 2, terminating in a closed end at *C*, had no branches between *B* and *C*, while from *A* to *B* there were about thirty branches drawing off a large supply which gradually diminished in quantity toward *B*. When the pipe had been forty-five years in continual use, it was inspected and found almost filled with rust at *A*, which gradually decreased, till between *B* and *C* the pipe was almost in its normal condition.

II.—CHEMICAL COMPOSITION.

The City Analyst, in reporting on the water supplied to Aberdeen, said: "Water containing 3 grains of the usual kinds of solids per gallon is of necessity soft, very suitable for washing, and unlikely to form much permanent deposit. But while, by the use of such soft water the tendency to incrustation of boilers is very much reduced, corrosion of boilers by means of the oxygen, and especially of the carbonic acid dissolved in water, is more likely to take place than by the use of hard water, there being little mineral in soft water by which this acid can be neutralized. * * * The softness of the water is owing to the insoluble granitic character of the district through which the Dee and its tributaries pass."

The solids present in the water amount to 2.94 grains per gallon, or 42 parts per million, and as in the following proportion:

	Grains.		Grains.
Sulphuric anhydride	0.333	Iron oxide and alumina	0.033
Nitric "	0.056	Silicia	0.253
Chlorine	0.798	Carbonic anhydride, lime, sodium, potassium and organic matter	0.952
Lime	0.336		
Magnesia	0.179		

Hardness = 1.11.

The following statements are also by the City Analyst, viz.:

NO. 1.—ANALYSIS OF RUST FROM A PIPE 4 IN. IN DIAMETER, WHICH HAD BEEN TWENTY-ONE YEARS IN CONTINUAL USE; NOT COATED WITH ASPHALT.

	Per cent.		Per cent.
Volative or combustible matter	16.62	Magnetic iron oxide	32.47
		Iron oxide	9.04
Sulphuric anhydride	0.60	Insoluble sandy matter	41.27
Phosphoric anhydride	slight trace	Lime	trace

NO. 2.—ANALYSIS OF RUST FROM A PIPE 10 IN. IN DIAMETER, WHICH HAD BEEN FIFTEEN YEARS IN CONTINUAL USE; COATED WITH DR. ANGUS SMITH'S PREPARATION OF ASPHALT.*

	Per cent.		Per cent.
Volative or combustible matter	18.05	Magnetic iron oxide	0.36
		Iron oxide	37.55
Sulphuric anhydride	1.08	Insoluble sandy matter	42.78
Phosphoric anhydride	trace	Lime	0.18

These samples do not materially differ, except in the condition of the iron, No. 1 being chiefly magnetic, while only a minute quantity of the iron of No. 2 is in that state.

III.—METHODS OF EXTRACTION.

Three methods have been tried to extract or get rid of the rust. The first was the clumsy, although sure, method of taking up the pipes, heating them and thereby detaching the rust. This mode is not now practiced, from the necessity of having to substitute a new main for the one taken up. The second is the extraction by manual labor, which is suitable for pipes from 2 to 5 in. in diameter; and in carrying it out the following operations must be performed: The lowest level in the pipe being selected, the ground for 2 ft. below its level is excavated so as to enable from five to eight men to work in the excavation. A portion of the pipe from 9 to 10 ft. long is cut out, and, if possible, a connection made between the bottom of the excavation and an adjoining sewer. If that cannot be done, pumping has to be resorted to. Before the pipe is cut the water is shut off above the level of the portion to be cleaned and allowed to escape at a cock below the point where it is to be cut. The tool used for detaching the rust (Fig. 3) has the cutting edge of steel, and of the same curvature as the internal diameter of the pipe, against which it is pressed by the action of a steel bow or spring, so placed as to require some force for the insertion of the tool. The tool or scraper is inserted into the pipe, and a connecting rod, of ¾-in. malleable iron tubes in lengths of 6 ft., is joined on. It is now driven forward by the men in the excavation, and drawn backward, accompanied by a rotary motion, so as to clean the entire circumference. The whole length of the pipe becomes gradually cleaned unless a bend should occur, when a fresh excavation has to be made, the pipe cut and operations commenced afresh. Coincident with the scraping a stream of water is made to run down the pipe, thus carrying the detached rust into the excavation, from which it is removed.

A jet pump (Fig. 4) is employed, both in this method and in that next to be described, to keep the excavation clear of the water falling into it from the pipe.

The following table gives the cost of cleaning various pipes by this method, including the maintenance of the streets opened or destroyed by the operations. The men were paid one-third more than the usual rate (inserted as additional time), as the work was carried on at night to avoid public inconvenience.

TABLE I—COST OF CLEANING WATER-MAINS BY MANUAL LABOR.

No.	Age of pipe.	Internal diameter of pipe.	Length cleaned.	Approximate amount of rust per lineal yard.	Total cost of operation.	Cost per lineal yard.
	Years.	Inches.	Yards.	Cubic Inches.	£. s. d.	d.
1	9	3	127	20	1 9 0	2.74
2	24	3	130	70	1 19 1	3.60
3	25	3	323	73	4 7 6	3.25
4	31	3	200	81	3 2 6	3.75
5	32	3	124	85	2 0 4	3.90
6	39	3	181	100	3 11 4	4.72
7	9	4	150	30	3 1 0	4.88
8	22	4	96	85	2 14 4	6.79
9	28	4	67	163	1 13 6	6.00
10	29	4	442	182	11 12 0	6.30
11	36	4	115	190	3 1 4	6.40
12	50	4	370	210	10 6 6	6.69
13	14	5	110	48	3 6 0	7.20
14	23	5*	543	194	26 0 0	11.48

									d.			
Average	cost	for	3-inch	pipes	3.656	per	lineal	yard.
"	"	"	4 "	"	6.176	"	"	"
"	"	"	5 "	"	9.340	"	"	"

* In this pipe several obstructions occured.

The following are the details of the cost of Nos. 4 and 12, table I.

NO. 4.
3-inch pipe, length 200 yards.

Time.			d.	£	s.	d.
6 hours,	foreman	at	7	= 0	3	6
26 "	junior do.	"	5	= 0	10	10
106 "	laborers	"	4	= 1	15	4
8 "	boy	"	2	= 0	1	4
Materials.						
2 new cast-iron collars				0	4	1
16 lbs. lead		"	2	= 0	2	8
2 " rope yarn		"	4½	= 0	0	9
Naphtha, for lamps				0	0	6
Coals				0	1	0
Cartage				0	2	6
Total				3	2	6

* The composition of the varnish is given in the patent taken out by Dr. Robert Angus Smith, F.R.S. The mode recommended for use should also be attended to.

NO. 12.
4-inch pipe, length 370 yards.

Time.			d.	£	s.	d.
34 hours,	foreman	at	7	= 0	19	10
78 "	junior do.	"	5	= 1	12	6
156 "	laborers	"	4½	= 2	18	6
125 "	"	"	4	= 2	1	8
10 "	boy	"	2	= 0	1	8
Watchman				0	10	0
Materials.			s.	d.		
3 yds. 4-inch cast-iron pipe		at	2	10 = 0	8	6
3 cast-iron collars, 1 cwt. 2 lbs.		"	8	3 = 0	8	4½
40 lbs. lead		"	0	2 = 0	6	8
9 " rope yarn		"	0	4½ = 0	3	4½
Naphtha					0	1	3
Cartage					0	5	0
Coals					0	3	0
Sundries					0	6	2
Total					10	6	6

In the third method of cleaning pipes, the machine used was manufactured by Messrs. Kennedy & Co., of Kilmarnock. It consists of an iron rod to which are attached two pistons and two sets of scrapers, one in front of the other; the scrapers, the front set being smaller in diameter than the other, are each made up of four strips of steel, about ⅛ in. thick by 2½ in. broad, and of equal length, sloping backwards from the rod to which they are attached, and at their outer terminations shaped and sharpened like the barbs of an arrow. This construction enables them to yield when coming in contact with a rigid projection, such as the nipple of a connection; and further the cutting diameter of each set may be altered by pressing in or pulling out the strips of steel. The pistons, which are of slightly less diameter than the pipe, are compound, and made up of three disks—one of iron, one of lead, and one of leather—the last two being cut into corresponding sectors and riveted firmly together. The pistons can easily be taken off the machine, and therefore, if it is thought advisable, one of larger or of smaller diameter may be readily substituted. This machine is illustrated in Fig. 5.

The addition of hatch-boxes (Fig. 6) is desirable, for by them not only is a permanent and easy access for subsequent examination obtained, but during any single operation the machine may be repeatedly and easily inserted and withdrawn. These boxes are of cast iron, and may be manufactured to suit any diameter of pipe. In all new works, hatch-boxes may, with advantage, be part of the system so as to be ready for use at any required time.

Having turned the water off the main, the hatch-box is fitted on at the upper end, and at the lower end the pipe is cut, and enough removed to let the machine be taken out. The machine is now inserted in the hatch-box and the lid bolted down; men are then stationed with improvised stethoscopes at distances of about 10 yards apart along the track of the pipe; the water is turned on, and, acting on the pistons, drives the machine forward. The noise of the advancing machine is communicated to each man in turn, who, as soon as it has passed, advances to a position ahead of his neighbors, and so on, thus forming a continuous line of observation. Any obstruction is in this manner immediately recognized and reported. Various expedients are tried to start the machine if it stops, such as shutting off the water for a few minutes and then suddenly turning it on, and this usually has the desired effect. The turbulent state of the water as it emerges tells whether or not the machine is in motion. The instrument having passed through the entire length of pipe, from which the water and rust have been removed, falls into the excavation at the lower end. It is advisable to pass the machine a second time through the pipe with the scrapers expanded and with larger pistons, after which the water is made to run till it emerges perfectly clear.

In pipes of 6 or 7-in. diameter, reduced by rust to about 5-in., where stoppages of the machine would readily occur, progress is materially assisted by horses being yoked to an intervening chain. The passage of the chain along the pipe, a matter of some difficulty, is best effected by floating down a hollow leather cone with a wooden rubber about 18 in. long (Fig. 7), to which one end of a cord is attached, the other end being tied to the chain.

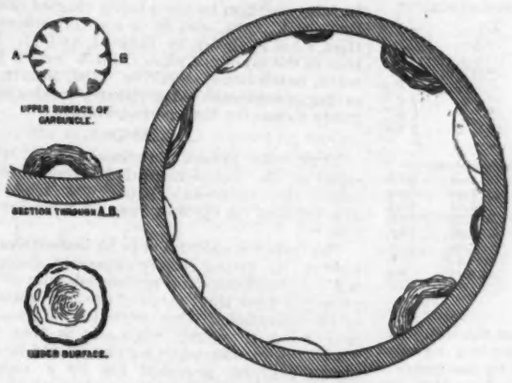
The machine originally, owing to its length, could not be passed along bends in the pipes. To overcome this, one set of scrapers and one piston were taken off, and in place of the rigid iron rod, one with a flexible joint has been substituted. By this change the machine has been made to pass bends of a radius of 3½ ft. The construction of this modification is shown in Fig. 8.

Should progress be obstructed in spite of every means to move the instrument, the ground above must be excavated, the pipe cut, and the machine taken out.

If both conditions for rapid progress be fulfilled,

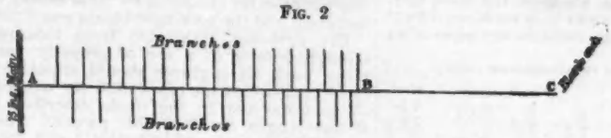
* Paper read before the Institution of Civil Engineers (London), by Mr. B. Jamieson, student Inst. C. E., and for which the Miller prize was awarded.

FIG. 1.



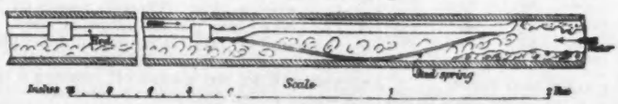
Asphalt Coated Pipe, 6 inches in diameter.
Scale, one-third full size.

FIG. 2



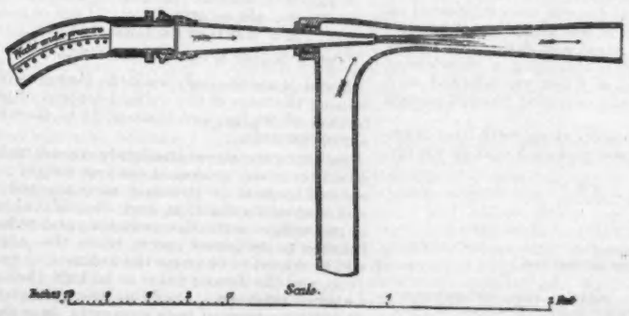
Pipe A B C.

FIG. 3.



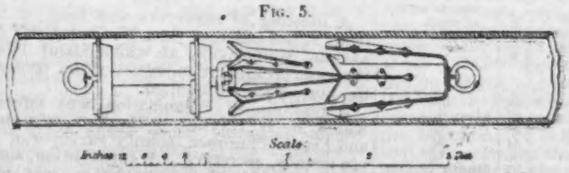
Machine for Cleaning by Manual Labor.

FIG. 4.



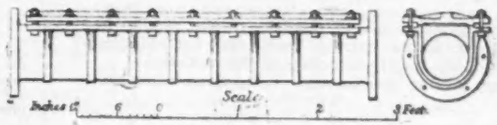
Jet Pump.

FIG. 5.



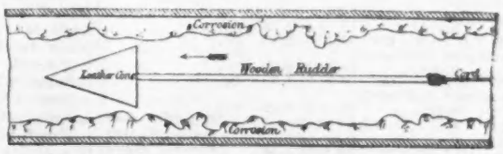
Machine for Cleaning by Water Pressure.

FIG. 6.



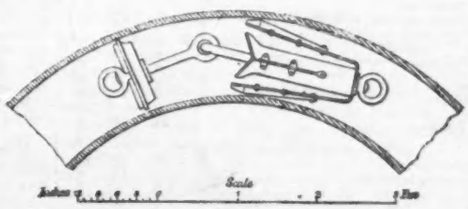
Hatch Box.

FIG. 7.



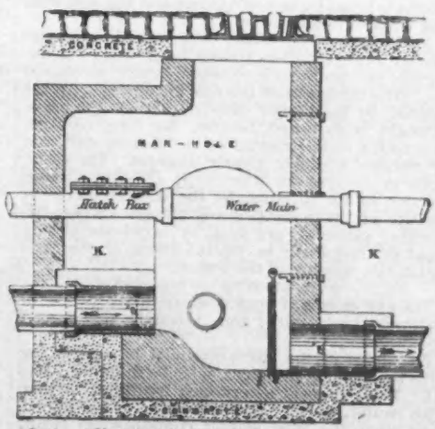
Floating Cone.
Scale, one-eighth full size.

FIG. 8.



Modification of Machine for Cleaning by Water Pressure.

FIG. 9.



Section of Manhole to facilitate pipe-cleaning by hatch-box.
Scale 1 inch = 1 foot.

viz., good pressure of water and little obstruction in the pipe, the machine may travel at the rate of about 6 miles an hour.

The operations must be carried on during the night, where the pipes are within the town, and in causewayed streets, in the former so as to cause as little inconvenience as possible to the public; in the latter so that carriage traffic may not be in the way of the speedy detection of obstructions.

TABLE II.—COST OF CLEANING WATER-MAINS BY WATER-PRESSURE.

No.	Age of pipe.	Size of pipe.	Length cleaned.	Approximate amount of corrosion per lineal yard.	Total cost of operation.	Cost per lineal yard.	Remarks.
	Yrs	In.	Yds.	Cu. in.	£. s. d.	d.	
1	10	6	539	210	19 18 0	8.86	Obstructions occurred, and machine had to be cut out of pipe.
2	20	6	240	334	7 4 0	7·20	Pressure of water not sufficient to put machine through without stoppages.
3	34	6	872	578	27 10 2	7.57	
4	15	7	1,500	138	9 13 8	1.54	Pipe coated with asphalt.
	Same pipe, with hatch-boxes.				22 4 7	3.55	Do.
5	15	9	1,933	153	19 12 0	2.43	Do.
	Same pipe, with hatch-boxes.				38 14 0	4.80	Do.
6	15	10	2,310	150	10 11 7	1.10	Do.
	Same pipe, with hatch-boxes.				30 10 0	3.16	Do.
7	40	15	1,043	1,700	29 19 0	6.89	Clip-joints used instead of hatch boxes. Hand pumping to free excavation of water.

Average cost of cleaning 6-in. pipes per yard .. ....7.87 d.

The following are the details of the cost of Nos. 3 and 6, Table II.:

NO. 3.

6-inch pipe, length 872 yards.

Time.			d.	£.	s.	d.
54 hours,	foreman	at	7	= 1	11	6
324 "	junior do	"	5	= 6	15	0
90 "	laborers	"	4¾	= 1	15	7½
108 "	"	"	4½	= 2	0	6
18 "	"	"	4¼	= 0	6	4½
414 "	"	"	4	= 6	18	0
46 "	causeway layers	"	5½	= 1	1	1
108 "	boys	"	2½	= 1	2	6
Materials.						
12 couplings and collars		"		2	16	7
112 lbs. lead		"	2	= 0	18	8
12 " rope yarn		"	4½	= 0	4	6
Naphtha				0	2	4
Coals				0	4	0
Sand				1	0	0
Carting				0	13	6
Total				27	10	2

NO. 6.

10-inch pipe, length 2,310 yards.

Time.			d.	£.	s.	d.
20 hours,	foreman	at	7	= 0	11	8
30 "	junior do	"	5½	= 0	13	9
30 "	laborers	"	5	= 5	12	6
60 "	"	"	4¾	= 1	3	9
120 "	"	"	4	= 2	0	0
30 "	"	"	4½	= 0	10	7½
Materials.			s.	d.		
4 10-inch thimbles		at	9	0	= 1	16	0
Lead, 2 qrs. per cwt		"	14	0	= 0	7	0
Rope yarn, 6 lbs		"	0	4½	= 0	2	3
Paraffine, 2 gals		"	0	7½	= 0	1	3
Coals, 1 cwt. 2 qrs		"	1	0	= 0	1	6
Carting					2	0	0
Sundries					0	11	3½
Total					10	11	7
Two 10-inch hatch-boxes					19	18	5
Total with hatch-boxes					30	10	0

The above table includes the cost of repairing streets injured by the operations and the cost with and without hatch-boxes.

As it is hardly possible to meet with two cases exactly alike, the dissimilarity in the cost of cleaning the various pipes is to some extent accounted for. The thickness of the rust in the case of pipes cleaned by hand labor does not affect the price, as might be expected, because the force required to detach a small amount of rust is also sufficient to remove a much greater amount. The variations in the cost are affected by different circumstances, as, for instance, by the distance between the site of the operations and the store where the working materials are kept, by accidents, and by want of uniformity in the thickness of the rusts and in the pressure of the water.

IV.—EVIL EFFECTS OF CORROSION.

The evil effects of corrosion are, first, the loss of water-carrying space, and, secondly, the loss of pressure.

Examples of the space occupied by rust, along with the ages of the pipes, will be found in Table III. This space is ascertained by filling the pipe with water, noting the quantity, deducting it from what the pipe should contain when clean, when the remainder gives the result required. The first four examples were taken where the circumstances attending the formation of rust were as nearly as possible the same, while the remainder were chosen at random.

Nos. 1 to 6 are of uncoated pipes; Nos. 7, 8 and 9 are of coated pipes.

TABLE III.

No.	Age of pipe.	Internal diameter of pipe.	Amount of rust per lineal yard.	Capacity of clean pipe per lineal yard.	Percentage of space occupied by rust.
	Years.	Inches.	Cubic inches.	Cubic inches.	
1	20	3	63.84	254.44	25.0
2	29	3	86.94	254.44	34.1
3	38	3	110.44	254.44	43.4
4	29	4	182.37	452.37	40.3
5	22	4	244.37	452.37	54 0
6	14	5	180.00	706.86	25.4
7	15	7	100.(about)	1,385.42	13.7
8	15	10	240.00	2,827.44	8.4
9	40	15	1,320.00	6,361.74	20.7

The rust has a marked effect on the discharge from a pipe; for instance, the water in a corroded pipe 3 in. in diameter, registered by the gauge a head of 77 ft., and through a 2-inch outlet (the same as that through which the pressure was measured) the discharge was only 16 gallons per minute; while, after cleaning, the pipe registered a head of 82 ft., and a discharge of 150 gallons per minute.

The following table gives additional examples; the results are the average gaugings of five different trials taken once a week on the same day. The theoretical head of water is in each case about 30 ft. more than that registered by the pipes after cleaning:

TABLE IV.—DISCHARGE FROM CORRODED PIPES.

No	Size of pipe.	Age of pipe.	Approximate amount of corrosion per lineal yard.	Head before cleaning.	Head after cleaning.	Discharge per minute before cleaning.	Discharge per min. after cleaning.
	In.	Yrs.	Cubic inches.	Feet.	Feet.	Gallons.	Gal.
1	3	29	86.94	42	47	47	143
2	3	29	93.00	54	56	79	188
3	3	29	the same pipe	70	74	143	200
4	3	32	100.00	77	82	16	150
5	3	32	100.00	72	72	115	187
6	3	26	80.00	56	62	35	220
7	3	26	88.00	36	43	65	130
8	4	29	100.00	40	45	69	115
9	4	29	the same pipe	38	42	125	107

V.—STRENGTH OF CORRODED PIPES.

It is difficult in the case of uncoated pipes to decide whether the strength of the pipe be affected more by the internal or by the external rust, as on inspection the inside of the pipe appears in a better condition than the outside when the rust has been removed.

The simplest mode of ascertaining the strength of corroded pipes was by finding their breaking weight. The pipes, selected with every possible care to avoid structural defects, were supported on a span of 4 feet, and force was applied in the centre till they broke. The same was done with a new pipe of similar size, thus obtaining a standard of comparison. The span of 4 feet was adopted, as it was difficult to get sound corroded pipes of greater length.

Table V. gives the results along with the calculated strength of the new pipe as found by the formula:

$$W = \frac{4\,K\,V}{L},$$

in which

W = breaking weight in cwt.
K = coefficient of rupture for cast iron.
L = length of span

$$V = 4.7\left(\frac{R^4 - r^4}{R}\right)$$

R = radius to outer surface and r = radius to internal surface of pipe.

TABLE V.—STRENGTH OF CORRODED PIPES.

No.	Age of pipe.	Size of pipe.	Thickness of metal.	Length of span.	Breaking weight, formula $W = \frac{4\,K\,V}{L}$	Actual breaking weight.	Actual deflection at centre of span.
	Yrs.	In.	In.	Feet.	Tons.	Tons.	Inch.
1	New	3	⅜	4	3.51	4.07	About ¾
2	13	3	⅜	4	"	2.45	" ⅜
3	13	3	⅜	4	"	2.44	" ⅜
4	29	3	⅜	4	"	2.06	" ¼
5	29	3	⅜	4	"	1.97	Hardly perceptible.

The external surface of pipes coated with asphalt remains in perfect condition for a considerably longer time than the internal surface.

In conclusion, the author is led to believe that the pipes of a town supplied with soft water, in which rust has once been removed, may be kept in fair condition by their being cleaned once every five or six years, and at a cost considerably less than what is shown in Tables I. and II.; further, that in the laying of pipes from 6 inches and upward, hatch-boxes should be fixed, thus in the end saving considerable expenditure, besides affording ready means for future examination.

ADDENDUM.

NOTE.—Mr. Robert Rawlinson, C. B., who presided at the Supplemental Meeting of Students when Mr. Jamieson's paper was read, has requested that his opinion may be recorded as follows:

This paper is calculated to be instructive by reason of its giving clearly-expressed descriptions, with well-defined diagrams and details of the implements used, their mode of use and tables of cuts of the operations. One useful lesson these details may teach to young engineers is that, in new water-works main-pipe cleaning should be contemplated and be provided for by a subdivision of the mains into areas and sections having hatch-boxes at suitable places. Each hatch-box should be in a manhole, having a movable cover at the street surface, and a bottom drain to remove water. Hatch-box covers may then be opened at any time without temporary damage to the street or road, and without injury to the mains, such as must be caused by cutting out a pipe or pipes. The facilities for cleansing by these means will be increased and the contingent costs much reduced.

The evidence obtainable from this paper is strongly in favor of a use of properly varnished pipes; and an engineer should stipulate in his specification that the pipes shall be treated with the material and in the mode described by Dr. Robert Angus Smith in his patent. The pipes should be cleaned and "fettled," and then at a temperature sufficient to expel some of the air from the skin of the pipe, and to dry the varnish quickly after dipping, the pipes and other castings should be dipped completely under, in a bath of the varnish, so as to coat the entire surfaces inside and outside of each pipe. With a use of proper varnish, and proper dipping and drying, each pipe, inside and outside, will then have a smooth, black, shining, varnish skin. There is reason to believe that in many cases gas-tar alone is used, which may account for failures known to take place, as gas-tar does not combine and harden as the proper varnish will do, but washes off, causing a taint in the water which discredits the process.

EARTHWORK CALCULATIONS.

New and short formula for calculating the cubical content of the section of an embankment from crown to toe, which consists of a wedge and two pyramids:

Let W = cubical content of wedge,
S = slope ratio,
R = width of road-bed.

$$\text{Cubical content of entire section} = W + \left[\frac{W \times 4\,S}{\frac{1}{2}R}\right]$$

S and R are the only variable elements in determining the ratio of the cubical content of pyramid to that of wedge, and their effect is shown in the above formula.

To prove the above absolutely correct, take such a section of any crown, slope and height; let the cubical content of pyramid as computed be the numerator of a fraction, and the cubical content of the wedge be the denominator, and reduce the fraction to its lowest terms, when the numerator will be found to be twice the assumed slope of the ratio, and the denominator to be half the assumed width of road-bed. Doubling the numerator will give the contents of both pyramids, as in the above formula. In case the ground slopes transversely, the excess of one pyramid will compensate for the deficiency in the other.—*Railroad Gazette.*

MINNESOTA ASSOCIATION OF SURVEYORS.

A meeting of surveyors was held on the 7th inst., at the office of Geo. W. Cooley, 411 Nicollet avenue, Minneapolis, at which about twenty of the most prominent members of the profession in the State were represented.

A preliminary organization was effected, of which M. B. Haynes, of Mankato, was chairman and Frank Plummer, county surveyor of Hennepin county, secretary. A constitution, similar to that of the Michigan association, was adopted,

and the secretary instructed to perfect the roll of membership by the addition of such names as may be presented before the next regular meeting, which is to be held at such time and place as will be hereafter advertised.

Parties desiring information concerning the above society may correspond with Frank Plummer, secretary of the association, at Minneapolis.

THE YEARLY CONSUMPTION OF RAILS.

We have for several years endeavored to establish as nearly as may be the yearly consumption of rails for maintenance in this country separately from that for renewals. The reports of production and importation are so complete that the total yearly consumption can be ascertained nearly enough. And the mileage of new railroads constructed each year we have ascertained so fully that a very close estimate of the consumption of rails for these can be made. Thus the total consumption for maintenance is reached by subtracting from the total consumption the amount used for new road. But what is the most important to know is the percentage of rails renewed yearly, which enables us to ascertain the average life of rails, and how far it has been lengthened by the introduction of steel, which is now laid on nearly all tracks that have a heavy traffic. This may seem an easy enough task. We have only to divide the tons of rails laid on the old roads during the year by the total tons in them at the beginning of the year, and, knowing their mileage, we can estimate nearly enough the tons of rails in them. Unfortunately, though the total mileage of *road* in the United States is pretty well established, the total of *track* has been reported so differently from year to year that we cannot feel at all sure that any statement of it in any year is correct. The only statistics that have been collected for miles of sidings, second tracks, etc., have been in Poor's Manual, and these have changed exasperatingly from year to year. On Jan. 1, 1877, the Manual reported 18,360 miles of such tracks, in 1878 only 18,1[illegible]0; in 1879 the enormous increase of 4,717 miles of these tracks was reported, making 22,817 in all. These last figures were accepted as probable corrections of previous errors, companies being more likely to omit reporting such mileage than most other facts concerning their roads; but for 1880 the Manual reported only 20,041 miles of these tracks—a *decrease* of 2,776 miles in a year in which there was much more than the usual amount of construction of this kind, the companies being generally prosperous, and the traffic growing so fast as to require additional tracks for its accommodation. Now comes the issue of 1881, reporting 21,978 miles of accessory tracks. This indicates an increase of 1,937 miles during the year. This is a reasonable amount, and until we have further corrections we shall take this last statement as a basis and adjust our estimates of consumption for maintenance and new accessory tracks from it.

Assuming the figures of 1880 to be correct, then, there were in the United States at the beginning of that year 106,623 miles of railroad *track*, and, according to the best estimates we can make, the rails in these tracks weighed 10,384,370 tons of 2,000 lbs.—crediting 61½ tons to narrow gauge and 99 to other tracks per mile.

Now, the approximate consumption of rails in the United States in 1880 was 1,674,235 short tons, of which there were required for the new railroad on which track was laid that year about 688,250 tons, leaving 986,000 tons for the maintenance of the 10,384,370 tons in track at the beginning of the year, and the construction of accessory tracks to these old roads. Neglecting the latter, we have 9.5 tons of new rails laid during the year for every 100 tons in the tracks.

By the last Manual we have the construction of 1,937 miles of new accessory tracks credited to 1880, requiring doubtless 191,700 short tons of rails, so that in all we may charge 880,000 tons of the consumption to new construction, leaving 794,000 tons to be charged purely to the maintenance of the 10,384,000 tons that were in the tracks at the beginning of the year, or 7.65 tons per 100, and 7.45 short tons or 6.65 long tons per mile of railroad track.

This has been the only year in which we could venture to assume that the reported addition to accessory track was even approximately correct. For previous years we are compelled to lump the amount required for such tracks with that required for maintenance, which, basing all calculations on the mileage reported in the manuals of 1880 and 1881, which makes the figures differ somewhat from those we have published heretofore, gives the consumption for construction of new roads, and for maintenance and additional tracks on old roads, as follows in successive years, in tons of 2,000 lbs.:

	Rail consumption.			Aggregate in tracks Jan. 1.
	Construction.	Maintenance.*	Total.	
1872	740,500	790.350	1,530,850	7,671,500
1873	392,000	758,849	1,148,849	8,412,000
1874	192,000	645,995	837,695	8,804 000
1875	151,000	659,770	810,770	9,996,000
1876	231,000	648,916	879,916	9,147,000
1877	206,000	558,744	764,744	9,378,000
1878	360,000	5 2.700	882,695	9,584,000
1879	440,000	717,420	1,157,420	9,944,000
1880	688,000	986,235	1,674,235	10,384,000
1881	.....	.....	.....	11,364,000

* Including new sidings and second tracks of old roads, which required, perhaps, 192,000 tons in 1880, but cannot be estimated for previous years.

With this consumption, the percentage of rails in old tracks required each year for maintenance and new accessory tracks has been:

Year.	Per cent.	Year.	Per cent.
1872	10.30	1877	5.95
1873	9.02	1878	5.54
1874	7.34	1879	7.22
1875	7.33	1880	9.50
1876	7.10		

The weak point in all these calculations, as we have intimated, is the absence of statistics of new accessory tracks each year. The percentages are not percentages of renewals, which is what we most desire to know, but of renewals plus this peculiar new construction. Were they renewals, the last year would show an astonishing increase in the rate. It was a year in which there was an extraordinary amount of renewals, there is no doubt, a great many companies then being able to make them which had needed them before; but it was also a year of much more than the ordinary amount of construction of second tracks and sidings, for the same reason, and also on account of the great growth of traffic on many roads. But allowing for 1,937 miles of such tracks, we have shown above that there remained a consumption equal to 7.65 per cent. of the rails in old tracks for maintenance alone, which is a larger consumption than in any previous year since 1873 for maintenance and new accessory tracks together, and consequently must be above the current average yearly wear. For though it is quite possible to put off needed renewals for one or two years, and, on roads of thin traffic where speed is not required, for a longer time, they cannot be postponed for any such length of time as is covered by the above tables, and for the last five years the actual consumption for maintenance must represent very accurately the actual wear of rails for that time. We cannot ascertain this exactly, but if we allow a consumption of 500,000 tons for second tracks and sidings in these five years (in the last of which 192,000 tons were used for these objects), we have a total consumption of 2,934,000 tons for maintenance, pure and simple, in five years, or an average of 587,000 tons yearly, and an *average yearly renewal* of almost exactly 6 per cent. (exactly 6.06) of all the rails in tracks, indicating the extraordinary average life or 16⅔ years for all rails.

We have heretofore laid special stress on the average renewals as indicating the effect of the use of steel rails, and we have cautioned our readers that the astounding improvement shown—the increase of the apparent average life of rails from 9.7 years in 1872 to 18 years in 1878—could not be maintained and was largely deceptive, for the reason that the renewals had been chiefly of steel, and that the steel rails would need scarcely any renewals within the period covered by the statistics, and indeed since any large mileage had been laid with them in this country, but yet were none the less wearing out, and would have to be renewed in large quantities as the limits of their life were approached. Probably we have begun to feel this, though we do not hear that anywhere yet have there been very great renewals of steel rails. But a further element which exaggerated the apparent decrease in the percentage of yearly renewals was doubtless the varying consumption for accessory tracks, which must have been much greater in the first two or three years than afterward until 1879 and 1880.

The renewals with steel continue, and at this date there are few tracks on which there is a heavy traffic which are of iron. Up to the end of 1880 about 4,475,000 short tons of steel rails had been laid on the railroads of the United States (1,074,000 tons in 1880 alone), and nearly 4,000,000 of these, we should say, are still in use, leaving at the beginning of this year but 7,270,000 tons of iron rails. By far the greater part of the tracks in this country have a light traffic, the roads of heaviest traffic, like the Pennsylvania, having twice as many miles in branches as in main lines, and the traffic on most branches being light. We should say that two-thirds or more of the traffic of the country now passes over steel rails, and the change of the other tracks from iron to steel will not cause anything like the decrease in yearly renewals that has been effected heretofore by using steel. Of the total consumption of rails only 6⅔ per cent. was steel in 1871 and 25 per cent. in 1873; but since 1876 more than half the annual consumption has been steel—in 1879, 62 per cent., and last year nearly 62 per cent., in spite of the enormous mileage of new railroads, for which iron is used much more than for renewals of old roads. Much of the new road under construction this year, however, will have steel rails; we are manufacturing much more steel than last year, Mr. Swank, in his admirable report to the American Iron and Steel Association, estimating a probable production of 1,250,000 short tons in 1881 and a capacity for 1,500,000 next year, while so far we have imported more steel than last year. The great demand for new roads may possibly increase the production and consumption of iron to the same extent, but probably not, as the increase in steel rail production this year will provide for about 3,000 miles of road. Thus we may expect a larger and larger proportion of our tracks to be laid with steel, with a further decrease in the average percentage of renewals, to which interruptions may be expected when the time comes for extensive renewals of the older steel rails. The experience of the last five years, we have shown, indicates already an average life of 16⅔ years for our rails, while nearly two-thirds of them were iron, and this is more than most people have been willing to admit as the life of steel on a road of considerable traffic.—*R. R. Gazette.*

PENNSYLVANIA SURVEYORS' CONVENTION.

ILLIANA, Ill., Aug. 20, 1881.

DEAR SIR: The Executive Committee appointed by the convention of engineers and surveyors, held last October in Harrisburg, has decided that, in consideration of the large majority of surveyors who prefer October as the month for meeting, that it will be best to hold the next convention in October.

A convention of the surveyors and engineers of Pennsylvania will therefore be held in Harrisburg, Pa., commencing Tuesday, Oct. 18, and continuing for several days.

This early notice of the meeting is given in the hope that many surveyors will be enabled to so plan their work that they can attend. Arrangements have been made with the Pennsylvania Railroad Company for special rates to and from the convention, and everything possible will be done to provide for the comfort and entertainment of surveyors when in Harrisburg.

A large attendance is expected, and the meeting promises to be one of very great interest to all surveyors and engineers. Besides discussing many important professional subjects, it is hoped that this convention will effect the organization of a permanent association of the surveyors of Pennsylvania.

A circular will be issued about Oct. 1, stating in detail place of meeting, hotel rates, and transportation arrangements. Yours very truly,

CHAS. E. BILLIN, Secretary and Treasurer.
Present address, Illiana, Edgar County, Ill.

PREVENTION OF SMOKE.

Mr. E. C. Engert, before the Society of Engineers, gave the following description of a simple apparatus for the prevention of smoke: The first principle underlying the construction of such devices must be not to allow the cold air to come in contact with the gases arising from green coals, and the furnace is, therefore, divided into two parts. The fire-door is removed from the boiler and a box fixed on in front. On each side of this box rails are placed inside, on which a plate or shutter may rest, which can be pushed forward or backward as required. When pushed forward it passes within the boiler and drops over the fire bars some 18 inches, thereby cutting off the draft and preventing the condensation of the gases arising when fresh coals are put on, thus preventing smoke and the cooling of the boiler. A still more simple apparatus can be made with the same results, if the opening or flue will admit a higher box. The shutters can be cast together in one piece at an angle of about 130 degrees, to hang within the box on two pins or bolts, thus forming a swinging shutter. A rack is attached to the front of the shutter to regulate the movement. The advantages of this apparatus are:

The cooling of the boiler is entirely avoided, the gases are consumed so that the smoke is prevented, and there is a saving of from 15 to 20 per cent. of heat and coal. This apparatus can easily be applied to locomotives. A box is placed under the foot-plate the whole width of the fire grate, and the coals put in from the top. By this means the gases are almost entirely drawn out of the coal and consumed, the result being that there is very little, if any, smoke. To supply the grate, the coal is pushed forward by a movable plate and lever.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

The Chicago Water "Crib" or inlet is to be improved $7,000 worth at once.

The people of Elgin, Ill., are discussing the subject of water-works for their city.

St. Thomas, Ont., will probably have to obtain a supply of water from a filtering basin in Kettle Creek, that being apparently the only scheme at present feasible.

A New York capitalist has offered to construct water-works for Peterboro', Ont., and run them as a private concern. He asks exemption from taxation and the usual privileges only.

A good cheap filter may be made by getting a sound barrel, putting a false bottom about one foot from the bottom, leaving a chamber below for the filtered water, the false bottom to have a great many small holes in it to allow the water to pass; then on the false bottom lay charcoal in pieces about the size of a hickory nut for six inches, then fill the rest of the space with charcoal in as small lumps as it can be broken into. There must be no charcoal dust, for the dust will wash through and blacken the water. Say one foot and a half charcoal, six inches of clean gravel on top, all pressed in tightly by hand, so as not to break the charcoal into dust. This makes a good filter and costs only a trifle.

STREETS, DRAINAGE, ETC.

The following is a list of the tenders for street work (grading and graveling) under resolution No. 81, opened by the Council of Wapakoneta, Ohio, on the 12th inst.:

O. Patterson, Baltimore, Md	17,348.20
Wm. McReynolds, Cleveland, O	15,000.00
Jos. Gearing, Wapakoneta, O	14,004.00
McCurdy & Monroe, Scioto, O	13,995.00
Edward Clark, New Bremen, O	13,262.96

The tender of Mr. Clark was accepted, and he was ordered to enter into contract and file his bond at the next meeting of the Council, Monday, Sept. 19, 1881.

BRIDGES.

Work has been begun on the new bridge of the I. & St. L., over White River at Indianapolis.

The P., Y. & C. R. R. Company is taking advantage of the low water in the river at Warren, Ohio, to rapidly push forward the construction of their bridge over the Mahoning.

The Wallis Iron Works, of Jersey City, N. J., are engaged in constructing a wrought-iron highway bridge 400 feet long, at Passaic, N. J., and have also bridges under way at Rahway and Boonton, N. J. They have also just completed three bridges for the Coney Island Elevated Railway Company. Their shops, which are quite extensive, are crowded with work.

RAILROADS.

Three corps of engineers are in Youngstown (O.) running lines for the Pittsburgh & Western Railroad. Within two weeks the work of grading will begin.

Both the Mexican National and the International railroads are rapidly completing their lines. The former is running to within seven miles of Laredo, and the latter to within fifty.—*N. Y. Sun.*

A railroad from Pittsfield to Williamstown, Mass., 25 miles distance, has been located, the entire capital of $600,000 subscribed for, and in a short time estimates for contract letting will be ready. Mr. Hunton, of Pittsfield, is Chief Engineer.

The articles incorporating the Chicago, St. Paul & Omaha Railroad were filed on Thursday of last week. The project includes the building of 500 miles of road from Chicago to Muscatine, Ia., via Freeport. The branches will cover nearly all of Illinois. Capital, $10,000,000.

The grades on the Western Division of the Lake Shore Railroad have been cut down. In some places they were reduced from ten to twelve inches. It is claimed that hereafter the grades will be so small that one engine can haul from sixty to seventy loaded cars from Chicago to Elkhart.

The Toronto and Ottawa is now located from Peterboro to the Coteau Road Landing, and men are at work grading. Tenders are now being asked for the construction of forty-seven miles from Madoc to Sharbot Lake. It will take three years to build the whole line, the length of which is 226 miles from Toronto to Ottawa, 50 miles shorter than by the Grand Trunk. The grades are easy, and the locating engineers have been at work all winter. The cost is estimated at $6,000,000.

As regards the Laredo boom, I cannot see any solid foundation for it. It is true that the holders of real estate ask enormous prices for their property, and as a rule, as regards living, I can say that it is the worst I ever encountered, and I have traveled over the greater part of the Continent. For the past two months I have not seen a green vegetable except what came in tin cans from Baltimore and New York. It has not rained here for three months, and therefore nothing in the vegetable line can be raised within 100 miles. Texas beef and mutton are the principal and only food obtainable at present on the Rio Grande.

LAREDO, TEX., Sept. 6.—This is the point at which two railroads are to cross the Rio Grande into Mexico. Laredo, Texas, is on the east bank, and New Laredo, Mexico, on the west bank of the river. There is some speculation in real estate here on the strength of the alleged importance of the point in the new railroad system. But in purchasing property the buyer cannot get a clear title. Until within the last two or three years, no record of the purchase or sale of land was kept in Webb County. All business was done by the inhabitants on the old Mexican plan of an equal division among the heirs without due course of law, and consequently no one will buy real estate, while those who hold it will not improve it.

Although the two railroads are fast approaching completion to Laredo, there are no accommodations of any kind for travelers. A room to sleep in cannot be had at any price, and a good round sum is charged for a cot placed under a shed in the yard. The town of Laredo, on the American side, is said to contain 5,000 inhabitants. I do not believe that 2,500 people could be found if a correct census were taken. The houses for the most part are built of mud, with dirt floors. There are about a dozen houses owned by Americans, which are of passable appearance, but they have none of the conveniences or comforts of the houses of the Southern or Northern States. Even people from the Eastern and Southern States who came to Laredo a dozen or more years ago have taken up with the habits of the old Mexican population, and now cannot be persuaded to change.

LEWISTON, Id., Sept. 12.—Major Truax, who went out to examine the approaches to Lolo Pass in the Bitter Root Mountains for railroad purposes, arrived here last night. He reports the route up Lolo Fork of the Clearwater to within fifteen miles of the summit as of good maximum grade, at no point exceeding fifty feet per mile, and a maximum grade at no point on the east fifteen miles exceeding a hundred feet per mile, which he believes can be reduced to seventy-five or eighty. From the summit east to Bitter Root River he found an easy grade. Another party are viewing out another pass to the south of this, which is claimed to be several hundred feet lower, called Shakas. The examination of Major Truax has refuted the theory of the Norther Pacific surveyors, who asserted that no railroad pass existed south of Pend d'Oreille. This route will shorten the railroad line from Ainsworth east to the mouth of the Bitter Root River by over one hundred miles.—*N. Y. World.*

What perfect system and management can do has been demonstrated upon several recent occasions by the Pennsylvania Railroad Company. When President Garfield was shot down on that fateful 2d of July his invalid wife was at Long Branch. The telegram announcing the shooting of her husband had hardly been placed in her hands until she was notified that a special train was being prepared to convey her with all the speed steam could make to Washington. When Drs. Hamilton and Agnew were summoned to the capital, a special train was waiting for them by the time they could get to the depot. When it was decided to remove the President, a hospital car was constructed in seven hours. A special track was laid, a train prepared and all ready hours before the surgeons were, and a sick and almost dying man carried 234 miles at a speed of nearly forty miles an hour, and yet with so little jar and confusion that the patient was not materially fatigued.

CHICAGO, Sept. 11.—The Board of Directors of the Pullman Palace Car Company at their meeting yesterday approved an official circular for distribution among the stockholders, setting forth that the money realized from the increase of the capital stock and the surplus revenues of the company have been expended in building car works, etc., at Pullman, Ill., and in devoting over $1,500,000 to increase the rolling stock and construction material to its equipment, and to the payment of its debenture bonds; that the interests of the company require a further expenditure of $2,000,000 upon its railway, water, sewerage, and other improvements, including 750 more homes for its workmen; that the income from these investments will be a fair return for the outlay; and authorizing a 25 per cent. increase of the entire capital stock of the company, giving stockholders the option to subscribe at par for the new stock pro rata; all shares subscribed for to be paid for on or before Nov. 16. The new stock will commence earning dividends on Nov. 1, 1881.

Railway managers in England have of late been giving careful attention to ways and means for diminishing the number of accidents on their roads. Long ago they found in the large sums, which the courts forced them to pay as damages to goods and to human life and well-being, that it was a field where economy ought more carefully to be practiced, and thus far their efforts have yielded results which cannot but be satisfactory to them from financial as well as from other points of view. These results have been reached mainly through improved devices for signals, better efficiency in the telegraph, and an increase of power in brakes. Some figures of the results, printed in a recent railway report, show the net gain from these improvements in a period of five years. Comparison is made of the first six months of 1876 with the first six of the present year, and it is found that there have been reductions varying from one-third to four-fifths. What is the more gratifying in this encouraging progress is the fact that the reductions were largely due to a diminution in the number of accidents to passengers. Thus, it is shown that out of the £55,636 paid by one of the roads in 1876, £44,222 was for personal injuries, and that while the total compensation reduction for that road, including both passengers and freight, was a little more than four-fifths, the reduction for the item of injuries to persons alone was eight-ninths, so that in freight there was a large percentage of increase instead of decrease. No doubt there is much other work that can and will be done in this same direction hereafter. The sum of $393,830 paid in one year for compensation by a single road, to say nothing of the loss a road sustains in engines, cars, and tracks ruined, represents the interest on several millions of money. One of the problems of the railroads still is this one of reducing the number and seriousness of their accidents. Practically, there ought seldom to be any accidents at all. One rarely happens without showing how, by a little more care and thoroughness, it might have been averted.

THE ERLANGER RAILWAY SYSTEM.—The Louisville & Nashville system is familiar to all who are interested in Southern railroads, but the Erlanger possessions are so disconnected at present, and the work of building necessary to complete the system is so scattered, that an account of the plans now being carried out will perhaps prove timely. I will give the main points, as detailed to me last week by Mr. Wolffe, with whom I happened to travel from New York to Cincinnati: "Count Erlanger, of Paris," he said, "together with his associates in London and Frankfort, put $25,000,000 cash in my hands early in last June, with instructions to carry out the plans for a railroad system in the South that I had laid before them. Our start was the ownership of the Alabama Southern road, formerly the Alabama & Chattanooga, extending from Chattanooga in a southwesterly direction to Meridian, Miss., a distance of 296 miles. This line is now in excellent condition and fully supplied with rolling stock. To the north all we want is the Cincinnati Southern, and I am going to Cincinnati now, feeling sure that our bid is the highest and best and we will get it. At Eutaw, Ala., which on reference to a map you will find on the Alabama Southern, near the Mississippi State line, we are making two extensions—one a distance of 175 miles in a direct line to Memphis, which is partly graded now and all under contract, and the other in a southeasterly direction to Brunswick, Ga., the only Southeastern port not controlled by the Louisville & Nashville Company. Between Eutaw and Brunswick a large part of the line is already in operation, as we own the line, 52 miles, between Eutaw and Selma, and the Brunswick and Albany road, 85 miles long. To connect these two we have to build a line 163 miles long from Selma to Albany, and the work is under contract now. At Meridian, Miss., the terminus of the Alabama Southern, we branch out directly west and again in a direct line to New Orleans. To the west we own the road from Meridian to Vicksburg, 145 miles, and crossing the Mississippi River, are building and have nearly completed the air line from Vicksburg to Shreveport, La., connecting at the latter point with the Texas Pacific and the entire system in the extreme Southwest. The line from Meridian to New Orleans is under way and will be pushed to completion as fast as possible. It will be 193 miles long. The Texas Pacific extension will be completed by March 1 next, and the entire system, by the terms of our rigid contracts, within thirteen months. In itself the system will be a complete one, and we will have full and friendly connections with nearly all the roads in the South east of the Mississippi."

To recapitulate the Erlanger system will include the following roads:

	Miles.
Cincinnati Southern	326
Alabama Southern	296
Meridian to Vicksburg	145
Vicksburg to Shreveport	196
Meridian to New Orleans	193
Eutaw to Memphis	175
Eutaw to Selma	52
Selma to Albany	163
Albany to Brunswick	85
Total	1,631

Continuing on the subject of the new era in the South Mr. Wolffe said: "The people in the North have just begun to realize that the South has awakened to her true interests, and, allowing politics to drop into the grave with slavery and reconstruction, is applying herself to the improvement of her material welfare with an energy and shrewdness worthy of a new country. The capitalists, who are always the first to understand the real conditions of a people's existence, have had perfect confidence in the South for some time, and the future of the section is so bright that money is absolutely pouring into it. The $25,000,000 that we are spending there is only an instance. Not only are many other railroad lines being built by added capital, but money in large blocks is being invested in lands, cotton mills, furnaces, iron works, lumber mills and various other enterprises. Why, the South is destined to supply the country and a good part of the world, not with raw cotton, but cotton goods of every variety. The sooner the Massachusetts manufacturer realizes this new rivalry and goes over to it the better for him. The South, old as it is, has just started 'a development.'"—*Correspondence N. Y. World.*